TEXAS INSTRUMENTS

**TPS92612**

SLVSFG3 – APRIL 2020

# TPS92612 40-V, 150-mA Single-Channel Linear LED Driver and Constant-Current Source With Protection

## 1 Features

- Single-channel high-precision current source:
  - ±4.6% Current accuracy from –40°C to +125°C
  - Current adjustable by external sense resistor
  - Up to 150 mA maximum current
- Wide input-voltage range: 4.5 V – 40 V
- Brightness control by input PWM duty cycle
- Low dropout voltage (current-sense voltage drop included)
  - Maximum dropout: 150 mV at 10 mA
  - Maximum dropout: 400 mV at 70 mA
  - Maximum dropout: 700 mV at 150 mA
- Low quiescent current: typical 200 µA
- Protection:
  - LED short-circuit protection with auto-recovery
  - Thermal shutdown
- Support heat sharing with external resistor
- Operating junction temperature range: –40°C to +150°C

## 2 Applications

- LED driver, constant current source, or current limiter for:
  - Washer and dryer
  - Refrigerator and freezer
  - Gas detector
  - Factory automation and control
  - Building automation
  - Medical

## 3 Description

With LEDs being widely used as a light source, simple LED drivers are more and more popular. Compared to discrete solutions, a low-cost monolithic solution lowers system-level component counts and significantly improves current accuracy and reliability.

The TPS92612 device is a single-channel high-side linear LED driver operating from a wide range supply. It is a simple, yet elegant solution to deliver constant current for a single LED string. It can support off-board LED connection with long cables. The TPS92612 device can also be used as a general constant current source or current limiter in other applications.

### Device Information[(1)]

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| TPS92612 | SOT-23 (5) | 2.9 mm × 1.6 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.
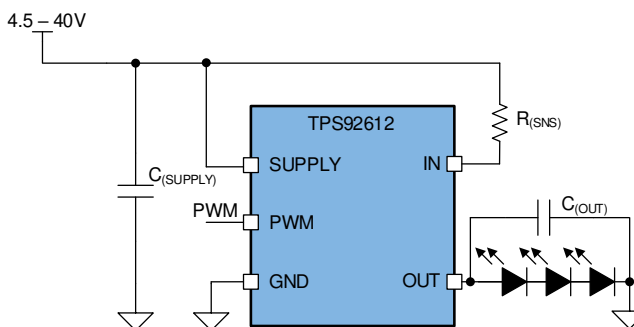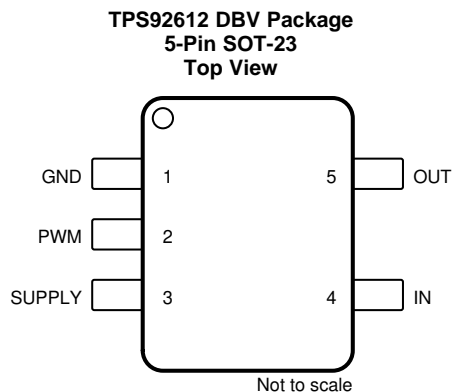
### Typical Application Diagram

# Table of Contents

# 4  Revision History

| DATE | REVISION | NOTES |
|---|---|---|
| April 2020 | * | Initial release. |

# 5 Pin Configuration and Functions

**TPS92612 DBV Package**
**5-Pin SOT-23**
**Top View**



Not to scale

**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| | TPS92612 | | |
| GND | 1 | — | Ground |
| IN | 4 | I | Current input |
| OUT | 5 | O | Constant-current output |
| PWM | 2 | I | PWM input |
| SUPPLY | 3 | I | Device supply voltage |

# 6 Specifications

## 6.1 Absolute Maximum Ratings

over operating ambient temperature range (unless otherwise noted)[1]

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| High-voltage input | IN, PWM, SUPPLY | –0.3 | 45 | V |
| High-voltage output | OUT | –0.3 | 45 | V |
| IN to OUT | $V_{(IN)} - V_{(OUT)}$ | –0.3 | 45 | V |
| SUPPLY to IN | $V_{(SUPPLY)} - V_{(IN)}$ | –0.3 | 1 | V |
| Operating junction temperature, $T_J$ | | –40 | 150 | °C |
| Storage temperature, $T_{stg}$ | | –40 | 150 | °C |

(1)  Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## 6.2 ESD Ratings

| | | | | VALUE | UNIT |
|---|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[1] | All pins | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101[2] | All pins | ±500 | |
| | | | Corner pins (3, 4, and 5) | ±750 | |

(1)  JEDEC document JEP155 states that 500-V HBM allows safemanufacturing with a standard ESD control process.
(2)  JEDEC document JEP157 states that 250-V CDM allows safemanufacturing with a standard ESD control process.

## 6.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

|  |  | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| SUPPLY | Device supply voltage | 4.5 | | 40 | V |
| IN | Sense voltage | 4.4 | | 40 | V |
| PWM | PWM inputs | 0 | | 40 | V |
| OUT | Driver output | 0 | | 40 | V |
| Operating ambient temperature, $T_A$ | | −40 | | 125 | °C |

## 6.4 Thermal Information

| | THERMAL METRIC | TPS92612 | UNIT |
|---|---|---|---|
| | | DBV (SOT23) | |
| | | 5 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 200.7 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 104.4 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 45.6 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 17.5 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 45.2 | °C/W |

## 6.5 Electrical Characteristics

$V_{(SUPPLY)}$ = 5 V to 40 V, $T_J$ = −40°C to +150°C unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **BIAS** | | | | | | |
| $V_{(POR\_rising)}$ | Supply voltage POR rising threshold | | | 3.2 | 4 | V |
| $V_{(POR\_falling)}$ | Supply voltage POR falling threshold | | 2.2 | 3 | | V |
| $I_{(Quiescent)}$ | Device standby current | PWM = HIGH | 0.1 | 0.2 | 0.25 | mA |
| **LOGIC INPUTS (PWM)** | | | | | | |
| $V_{IL(PWM)}$ | Input logic-low voltage, PWM | | 1.045 | 1.1 | 1.155 | V |
| $V_{IH(PWM)}$ | Input logic-high voltage, PWM | | 1.16 | 1.2 | 1.24 | V |
| **CONSTANT-CURRENT DRIVER** | | | | | | |
| $I_{(OUT)}$ | Device output-current range | 100% duty cycle | 4 | | 150 | mA |
| $V_{(CS\_REG)}$ | Sense-resistor regulation voltage | $T_A$ = 25°C, $V_{(SUPPLY)}$ = 4.5 V to 18 V | 94 | 98 | 102 | mV |
| | | $T_A$ = −40°C to +125°C, $V_{(SUPPLY)}$ = 4.5 V to 18 V | 93.5 | 98 | 102.5 | |
| $R_{(CS\_REG)}$ | Sense-resistor value | | 0.66 | | 24.5 | Ω |
| $V_{(DROPOUT)}$ | Voltage dropout from SUPPLY to OUT | $V_{(CS\_REG)}$ voltage included, current setting of 10 mA | | 120 | 150 | mV |
| | | $V_{(CS\_REG)}$ voltage included, current setting of 70 mA | | 250 | 400 | |
| | | $V_{(CS\_REG)}$ voltage included, current setting of 150 mA | | 430 | 700 | |
| **DIAGNOSTICS** | | | | | | |
| $V_{(SG\_th\_rising)}$ | Channel output $V_{(OUT)}$ short-to-ground rising threshold | | 1.14 | 1.2 | 1.26 | V |
| $V_{(SG\_th\_falling)}$ | Channel output $V_{(OUT)}$ short-to-ground falling threshold | | 0.82 | 0.865 | 0.91 | V |
| $I_{(Retry)}$ | Channel output $V_{(OUT)}$ short-to-ground retry current | | 0.64 | 1.08 | 1.528 | mA |
| **THERMAL PROTECTION** | | | | | | |
| $T_{(TSD)}$ | Thermal shutdown junction temperature threshold | | 157 | 172 | 187 | °C |
| $T_{(TSD\_HYS)}$ | Thermal shutdown junction temperature hysteresis | | | 15 | | °C |

## 6.6 Timing Requirements

|  |  | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $t_{(PWM\_delay\_rising)}$ | PWM rising edge delay, 50% PWM voltage to 10% of output current closed loop, t2 - t1 as shown in Figure 1 | 10 | 17 | 25 | µs |

## Timing Requirements (continued)

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| t(PWM_delay_falling) | PWM falling edge delay, 50% PWM voltage to 90% of output current open loop, t5 - t4 as shown in Figure 1 | 15 | 21 | 30 | µs |
| t(DEVICE_STARTUP) | SUPPLY rising edge to 10% output current at 50-mA set current, t8 - t7 as shown in Figure 1 | | 100 | 150 | µs |
| t(SG_deg) | Output short-to-ground detection deglitch time | 80 | 125 | 175 | µs |
| t(TSD_deg) | Thermal over temperature deglitch timer | | 50 | | µs |
| t(Recover_deg) | Fault recovery deglitch timer | 8.5 | 16 | 25 | µs |
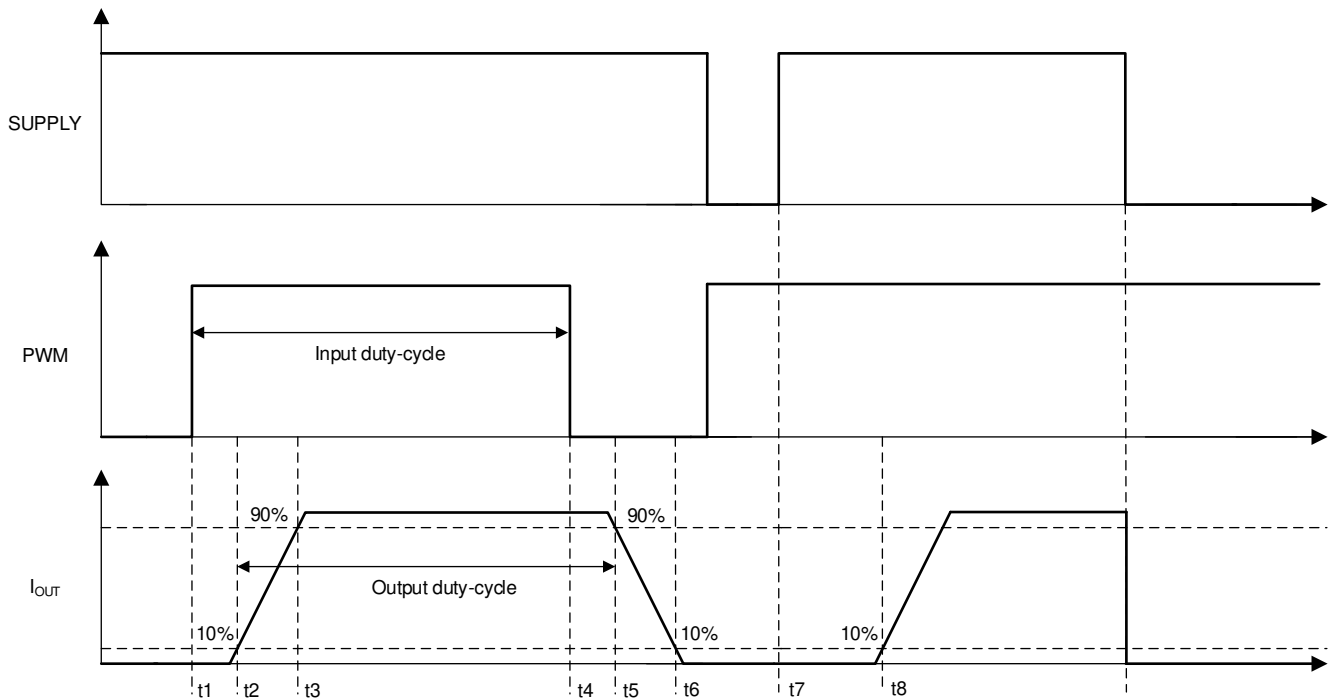


**Figure 1. Output Timing Diagram**

## 6.7 Typical Characteristics
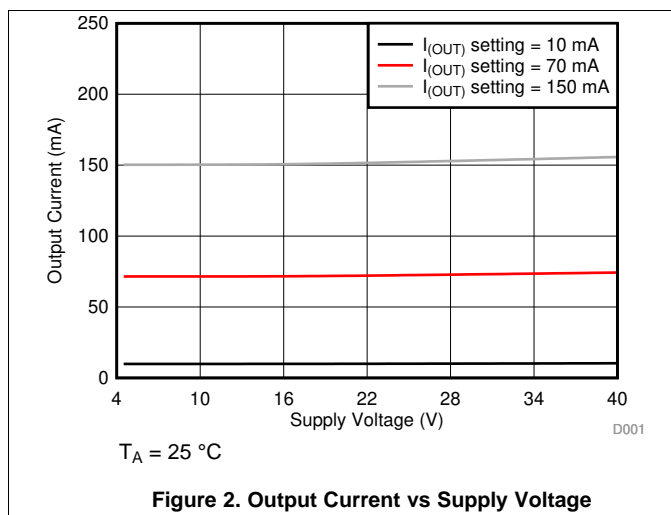

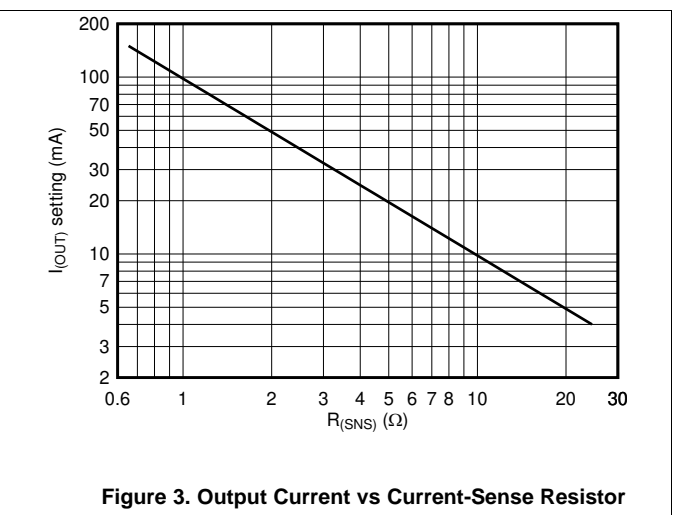
**Figure 2. Output Current vs Supply Voltage**



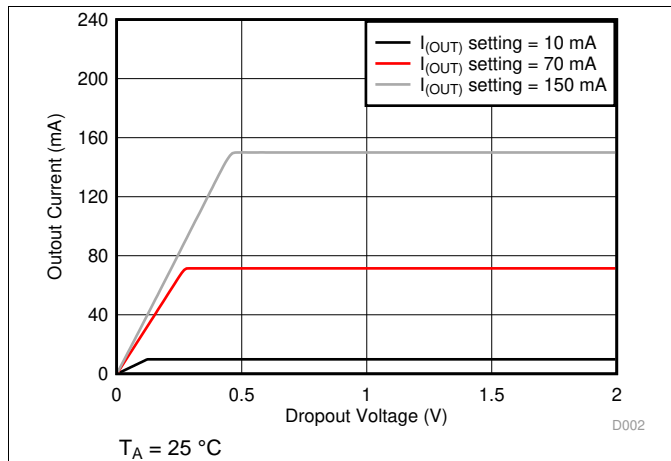**Figure 3. Output Current vs Current-Sense Resistor**

Product Folder Links: TPS92612

## Typical Characteristics (continued)



$T_A = 25\ °C$

**Figure 4. Output Current vs Dropout Voltage**



$I_{(OUT)}$ setting = 150 mA
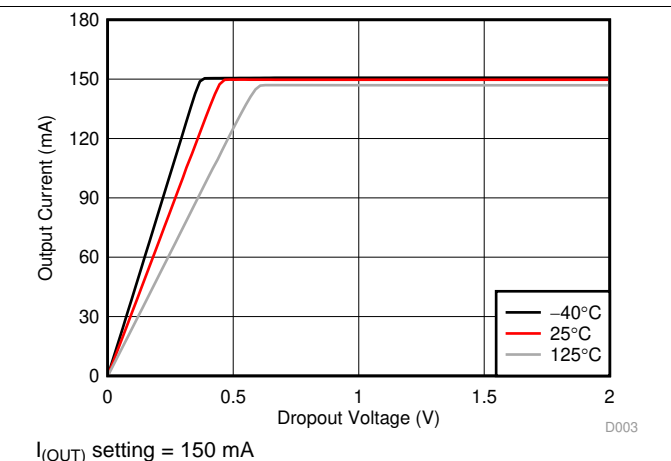
**Figure 5. Output Current vs Dropout Voltage**



$I_{(OUT)}$ setting = 150 mA

$V_{(SUPPLY)} - V_{(OUT)} = 2\ V$
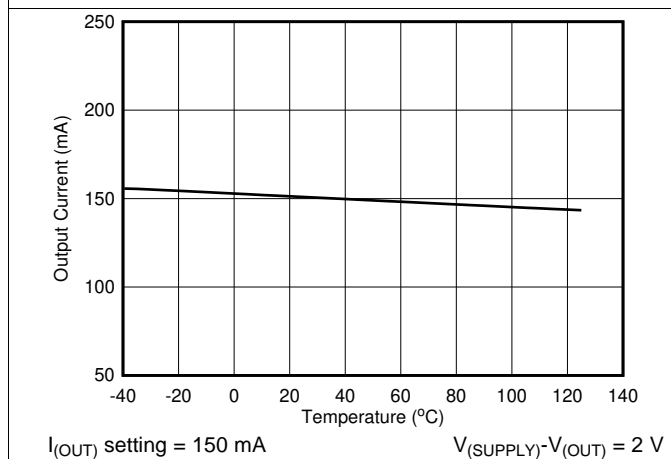
**Figure 6. Output Current vs Temperature**



$f_{(PWM)} = 200\ Hz$
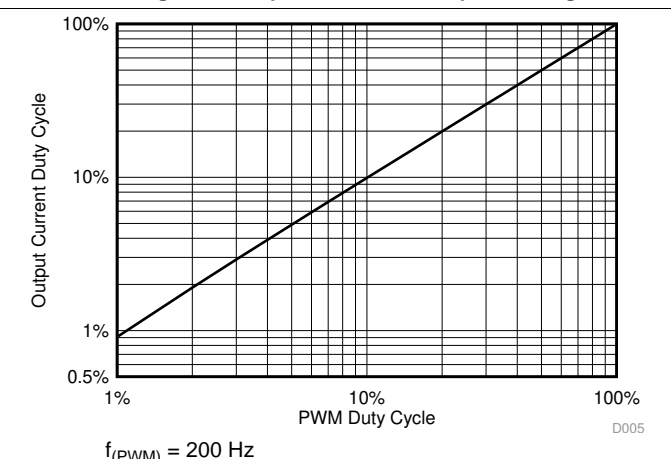
**Figure 7. PWM Output Duty Cycle vs Input Duty Cycle**



Ch. 1 = SUPPLY          Ch. 2 = V$_{(PWM)}$          Ch. 4 = I$_{(OUT)}$

$f_{(PWM)} = 200\ Hz$     Duty-cycle = 50%
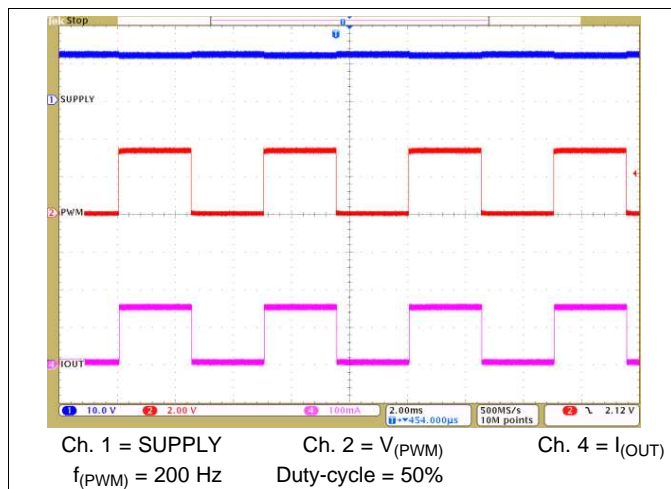
**Figure 8. PWM Dimming at 200 Hz**



Ch. 1 = SUPPLY          Ch. 2 = V$_{(PWM)}$          Ch. 4 = I$_{(OUT)}$

$f_{(PWM)} = 2\ kHz$     Duty-cycle = 50%
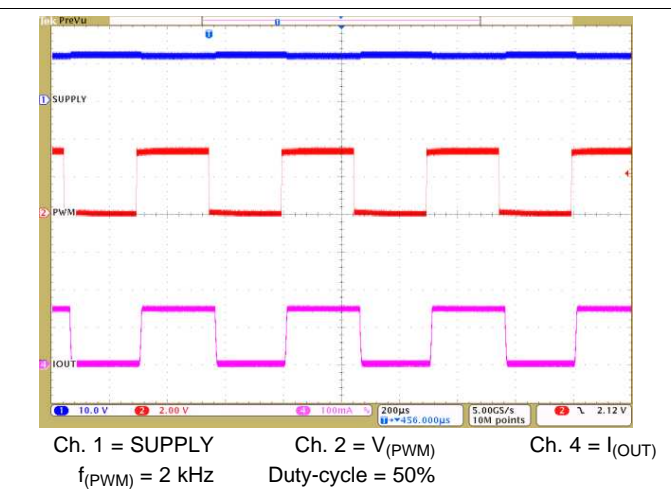
**Figure 9. PWM Dimming at 2 kHz**

Product Folder Links: *TPS92612*

## Typical Characteristics (continued)



Ch. 1 = SUPPLY          Ch. 2 = V$_{(OUT)}$          Ch. 4 = I$_{(OUT)}$

**Figure 10. LED Open-Circuit and Recovery**



Ch. 1 = SUPPLY          Ch. 2 = V$_{(OUT)}$          Ch. 4 = I$_{(OUT)}$

**Figure 11. LED Short-Circuit Protection and Recovery**
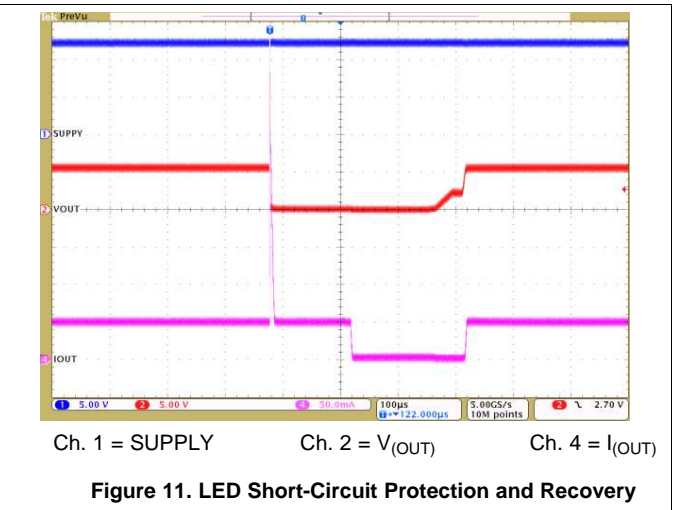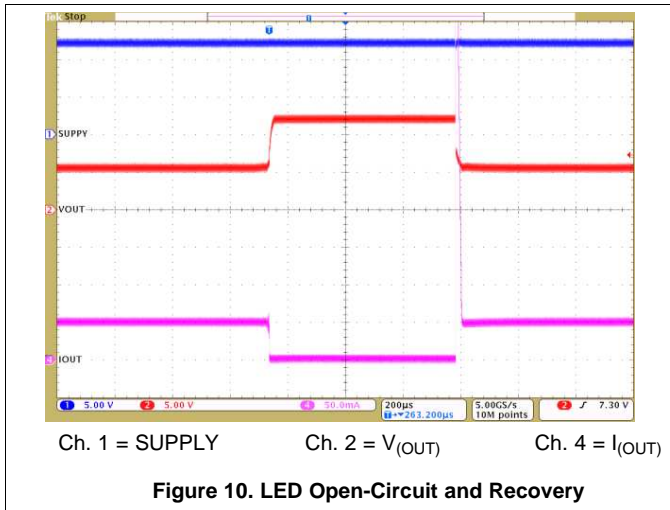
# 7 Detailed Description

## 7.1 Overview

The TPS92612 device is a single-channel linear LED driver providing a simple current source with protection.

The output current at OUT pin can be set by an external $R_{(SNS)}$ resistor. Current flows from the supply through the $R_{(SNS)}$ resistor into the integrated current regulation circuit and to the output through OUT pin. Brightness can be controlled by PWM pin.

## 7.2 Functional Block Diagram
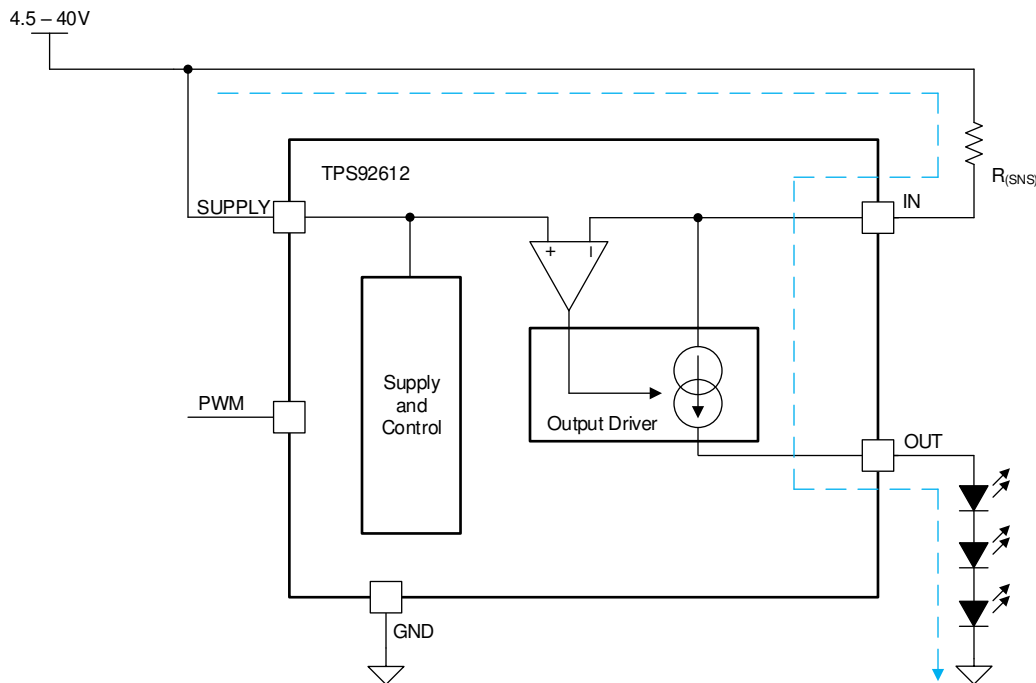


## 7.3 Feature Description

### 7.3.1 Device Bias

#### 7.3.1.1 Power-On Reset (POR)

The TPS92612 device has an internal power-on-reset (POR) function. When power is applied to the SUPPLY pin, the internal POR holds the device in the reset condition until $V_{(SUPPLY)}$ reaches $V_{(POR\_rising)}$.

### 7.3.2 Constant-Current Driver

The TPS92612 device is a high-side constant-current driver. The device controls the output current through regulating the voltage drop on an external high-side current-sense resistor, $R_{(SNS)}$. An integrated error amplifier drives an internal power transistor to maintain the voltage drop on the current-sense resistor $R_{(SNS)}$ to $V_{(CS\_REG)}$ and therefore regulates the current output to target value. When the output current is in regulation, the current value can be calculated by using Equation 1.

$$I_{(OUT)} = \frac{V_{(CS\_REG)}}{R_{(SNS)}}$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)         (1)

Product Folder Links: *TPS92612*

## Feature Description (continued)

When the SUPPLY-to-OUT voltage difference is below the required dropout voltage, $V_{(DROPOUT)}$, at a given output current, the TPS92612 is not able to deliver enough current output as set by the value of $R_{(SNS)}$, and the voltage across the current-sense resistor $R_{(SNS)}$ is less than $V_{(CS\_REG)}$.

### 7.3.3  PWM Control

The pulse width modulation (PWM) input of the TPS92612 functions as enable for the output current. When the voltage applied on the PWM pin is higher than $V_{IH(PWM)}$, the output current is enabled. When the voltage applied on PWM pin is lower than $V_{IL(PWM)}$, the output current is disabled. Besides output current enable and disable function, the PWM input of TPS92612 also supports adjustment of the average current for LED brightness control. TI recommends a 200 Hz – 2 kHz PWM signal for brightness control, which is out of visible frequency range of human eyes.

### 7.3.4  Protection

#### 7.3.4.1  Short-to-GND Protection

The TPS92612 device has OUT short-to-GND protection. The device monitors the $V_{(OUT)}$ voltage when the output current is enabled and compares it with the internal reference voltage to detect a short-to-GND failure. If $V_{(OUT)}$ falls below $V_{(SG\_th\_falling)}$ longer than the deglitch time of $t_{(SG\_deg)}$, the device asserts the short-to-GND fault. During the deglitching time period, if $V_{(OUT)}$ rises above $V_{(SG\_th\_rising)}$, the timer is reset.

Once the device has detected a short-to-GND fault, the device turns off the output channel and retries automatically by sourcing a small current $I_{(retry)}$ from IN to OUT to pull up the loads continuously, regardless of the state of the PWM input. Once auto retry detects output voltage rising above $V_{(SG\_th\_rising)}$, the device clears the short-to-GND fault and resumes normal operation.

#### 7.3.4.2  Over Temperature Protection

The TPS92612 device monitors device junction temperature. When the junction temperature reaches thermal shutdown threshold $T_{(TSD)}$, the output shuts down. Once the junction temperature falls below $T_{(TSD)} - T_{(TSD\_HYS)}$, the device recovers to normal operation.

## 7.4  Device Functional Modes

### 7.4.1  Undervoltage Lockout, $V_{(SUPPLY)} < V_{(POR\_rising)}$

When the TPS92612 device is in undervoltage lockout mode, the device disables all functions until the supply rises above the $V_{(POR\_rising)}$ threshold.

### 7.4.2  Normal State, $V_{(SUPPLY)} \geq 4.5$ V

The device regulates output current in normal state. With enough voltage drop across SUPPLY and OUT, the device is able to drive the output in constant-current mode.

# 8 Application and Implementation

**NOTE**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 8.1 Application Information

The TPS92612 device is a constant-current regulator which can be used as a LED driver, general constant-current source or current limiter in industrial applications.

Thermal performance is one of the design challenges for linear devices. To increase current-driving capability, the device supports heat sharing using an external parallel resistor, as shown in Figure 15. This technique provides the low-cost solution of using external resistors to minimize thermal accumulation on the device itself, and still keeps high accuracy of the total current output.

## 8.2 Typical Application

### 8.2.1 Single LED Driver

The TPS92612 offers a cost-effective and easy-to-use solution for LED driver applications. PWM input can be adopted for LED brightness adjust and LED ON/OFF control. The device also supports off-board LED connection with long cables.
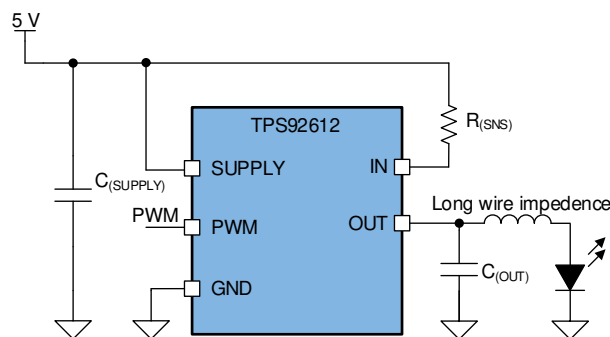


**Figure 12. Typical Application Diagram**

#### 8.2.1.1 Design Requirements

The input voltage is 5 V ± 5%. LED maximum forward voltage $V_{F\_MAX}$ = 2.5 V, minimum forward voltage $V_{F\_MIN}$ = 1.9 V, current $I_{(LED)}$ = 150 mA. LED is connected to device OUT pin through a 1-m long wire.

#### 8.2.1.2 Detailed Design Procedure

**STEP 1**: Determine the current setting resistor, $R_{(SNS)}$ value by using Equation 2.

$$R_{(SNS)} = \frac{V_{(CS\_REG)}}{I_{(LED)}} = 0.653\Omega$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)
- $I_{(LED)}$ = 150 mA

(2)

**STEP 2**: Power consumption analysis for the worst application conditions.

## Typical Application (continued)

Normally the thermal analysis is necessary for linear LED-driver applications to ensure that the operation junction temperature of TPS92612 is well managed. The total power consumption on the TPS92612 itself is one important factor determining operation junction temperature, and it can be calculated by using Equation 3. Based on the worst-case analysis for maximum power consumption on device, consider either optimizing PCB layout for better power dissipation as *Layout* describes or adding an extra heat-sharing resistor as described in *Single-Channel LED Driver With Heat Sharing*.

$$P_{(DEV)} = \left( V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)} \right) \times I_{(LED)} + V_{(SUPPLY)} \times I_{(Quiescent)}$$

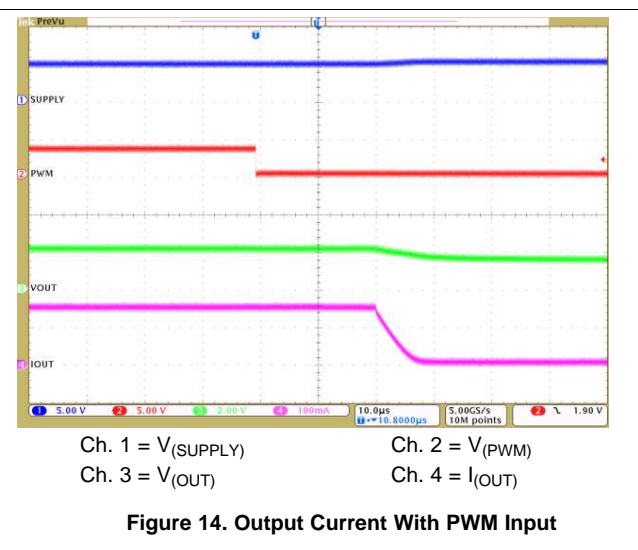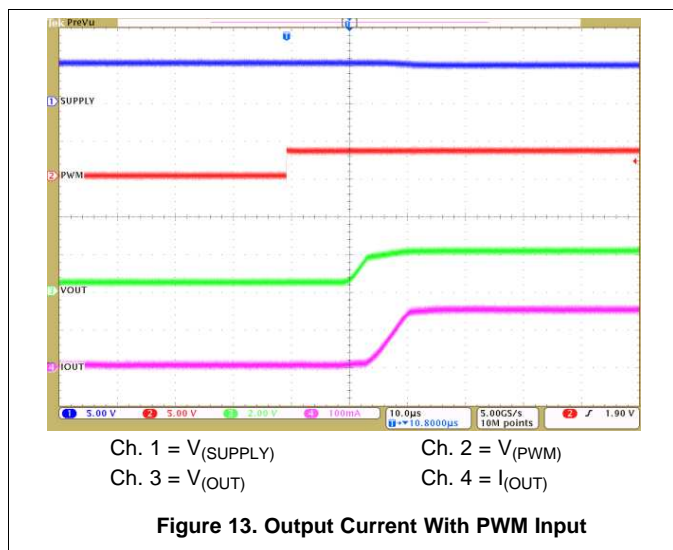$$P_{(DEV\_MAX)} = \left( 5.25 - 0.098 - 1.9 \right) \times 0.15 + 5.25 \times 0.00025 = 0.489W$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)
- $I_{(Quiescent)}$ = 250 µA (maximum)                                                                 (3)

In this application, the calculated result for maximum power consumption on the TPS92612 is 0.489 W at $V_{(SUPPLY)}$ = 5.25 V and $I_{(LED)}$ = 150 mA conditions.

TI recommends to add capacitors $C_{(SUPPLY)}$ at SUPPLY and $C_{(OUT)}$ at OUT. TI recommends one 1-µF capacitor plus one 100-nF decoupling ceramic capacitor close to the SUPPLY pin for $C_{(SUPPLY)}$ and a 10-nF ceramic capacitor close to the OUT pin for $C_{(OUT)}$. The larger capacitor for $C_{(SUPPLY)}$ or $C_{(OUT)}$ is helpful for EMI and ESD immunity; however, large $C_{(OUT)}$ takes a longer time to charge up the capacitor and may affect PWM dimming performance.

### 8.2.1.3 Application Curve

A 1-µH inductor is connected between OUT and the LED to simulate the 1-m long cable.



Ch. 1 = $V_{(SUPPLY)}$  Ch. 2 = $V_{(PWM)}$
Ch. 3 = $V_{(OUT)}$  Ch. 4 = $I_{(OUT)}$

**Figure 13. Output Current With PWM Input**



Ch. 1 = $V_{(SUPPLY)}$  Ch. 2 = $V_{(PWM)}$
Ch. 3 = $V_{(OUT)}$  Ch. 4 = $I_{(OUT)}$

**Figure 14. Output Current With PWM Input**

### 8.2.2 Single-Channel LED Driver With Heat Sharing

Using parallel resistors, thermal performance can be improved by balancing current between the TPS92612 device and the external resistors as follows. As the current-sense resistor controls the total LED string current, the LED string current $I_{(LED)}$ is set by $V_{(CS\_REG)}$ / $R_{(SNS)}$, while the TPS92612 current $I_{(DRIVE)}$ and parallel resistor current $I_{(P)}$ combine to the total current.
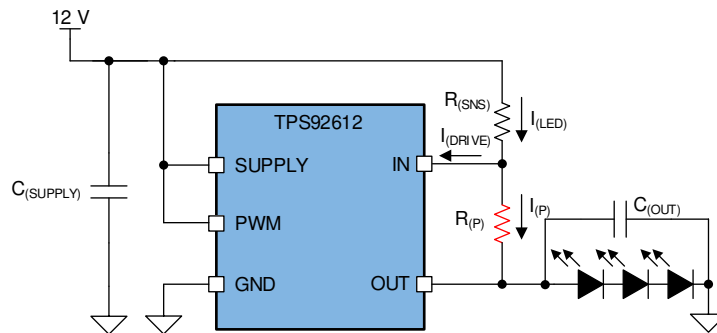
## Typical Application (continued)



**Figure 15. Heat Sharing With a Parallel Resistor**

### 8.2.2.1 Design Requirements

The input voltage range is 12 V ± 10%, LED maximum forward voltage $V_{F\_MAX}$ = 2.5 V, minimum forward voltage $V_{F\_MIN}$ = 1.9 V, current $I_{(LED)}$ = 150 mA.

### 8.2.2.2 Detailed Design Procedure

In linear LED driver applications, the input and output voltage variation generates the most of the thermal concerns. The resistor current $I_{(P)}$, as indicated by Ohm's law, depends on the voltage across the external resistors. The TPS92612 controls the driver current $I_{(DRIVE)}$ to attain the desired total current. If $I_{(P)}$ increases, the TPS92612 device decreases $I_{(DRIVE)}$ to compensate, and vice versa. The parallel-resistor takes highest current and generates maximum heat at maximum supply voltage and minimum LED-string forward voltage.

The parallel resistor value must be carefully calculated to ensure that 1) thermal dissipation for both the TPS92612 device and the resistor is within their thermal dissipation limits, and 2) device current at high voltage drop condition is above the minimal output-current requirement.

**STEP 1**: Determine the current setting resistor, $R_{(SNS)}$ value by using Equation 4.

$$R_{(SNS)} = \frac{V_{(CS\_REG)}}{I_{(LED)}} = 0.653\Omega$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)
- $I_{(LED)}$ = 150 mA                                                                                                   (4)

The calculated result for $R_{(SNS)}$ is 0.653 Ω.

**STEP 2**: Calculate the parallel resistor, $R_{(P)}$ value by using Equation 5.

The parallel resistor $R_{(P)}$ is recommended to consume 50% of the total current at maximum supply voltage and minimum LED-string forward voltage.

$$R_{(P)} = \frac{V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)}}{0.5 \times I_{(LED)}} = \frac{13.2 - 0.098 - 3 \times 1.9}{0.5 \times 0.15} \approx 100\Omega$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)
- $I_{(LED)}$ = 150 mA                                                                                                   (5)

The calculated result for $R_{(P)}$ is about 100 Ω at $V_{(SUPPLY)}$ = 13.2 V.

**STEP 3**: Power consumption analysis for the worst application conditions.

The total device power consumption can be calculated by Equation 6.

## Typical Application (continued)

$$P_{(DEV)} = \left( V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)} \right) \times \left( I_{(LED)} - \frac{V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)}}{R_{(P)}} \right) + V_{(SUPPLY)} \times I_{(Quiescent)}$$

$$P_{(DEV\_MAX)} = \left( 13.2 - 0.098 - 3 \times 1.9 \right) \times \left( 0.15 - \frac{13.2 - 0.098 - 3 \times 1.9}{100} \right) + 13.2 \times 0.00025 = 0.566W$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)
- $I_{(Quiescent)}$ = 250 µA (maximum)                                                                    (6)

The calculated maximum power consumption on the TPS92612 device is 0.566 W at $V_{(SUPPLY)}$ = 13.2 V, $V_{(OUT)}$ = 3 × 1.9 V = 5.7 V and $I_{(LED)}$ = 150 mA.

The power consumption on resistor $R_{(P)}$ can be calculated through Equation 7.

$$P_{(RP)} = \frac{\left( V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)} \right)^2}{R_{(P)}}$$

$$P_{(RP\_MAX)} = \frac{\left( 13.2 - 0.098 - 3 \times 1.9 \right)^2}{100} = 0.548W$$

where

- $V_{(CS\_REG)}$ = 98 mV (typical)                                                                    (7)

The calculated maximum power consumption on the 100 Ω, $R_{(P)}$ parallel resistor is 0.548 W at $V_{(SUPPLY)}$ = 13.2 V and $V_{(OUT)}$ = 3 × 1.9 V = 5.7 V.

TI recommends adding capacitors $C_{(SUPPLY)}$ at SUPPLY and $C_{(OUT)}$ at OUT. One 1-µF capacitor plus one 100-nF decoupling ceramic capacitor close to the SUPPLY pin is recommended for $C_{(SUPPLY)}$, and a 10-nF ceramic capacitor close to the OUT pin is recommended for $C_{(OUT)}$. The larger capacitor for $C_{(SUPPLY)}$ or $C_{(OUT)}$ is helpful for EMI and ESD immunity, however large $C_{(OUT)}$ takes a longer time to charge up the capacitor and could affect PWM dimming performance.

Note that the parallel resistor path cannot be shut down by PWM or fault protection. If PWM control is required, TI recommends an application circuit as shown in Figure 16. A NPN bipolar transistor with a base current-limiting resistor, $R_1$, can modulate the output current together with the device PWM function. The resistor value of $R_1$ needs to be calculated based on the applied PWM voltage and β value of selected NPN transistor.
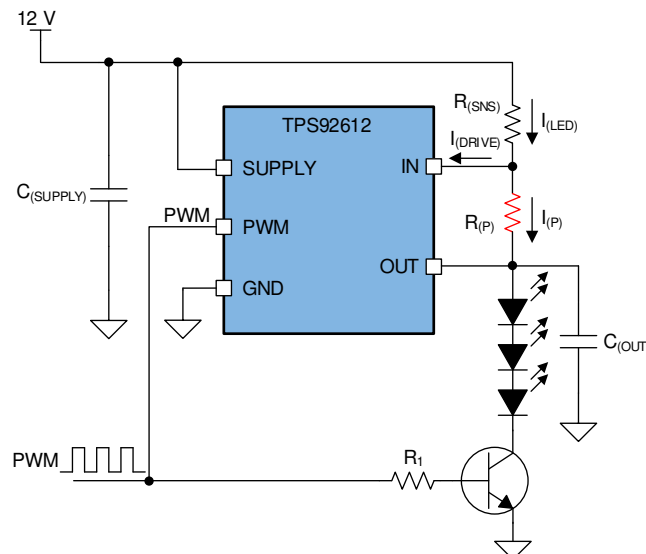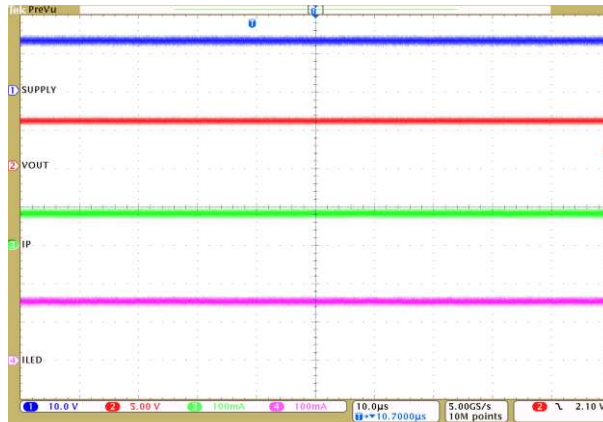


**Figure 16. PWM Control With Heat Sharing Resistor**

## Typical Application (continued)

### *8.2.2.3 Application Curve*



Ch. 1 = V$_{(SUPPLY)}$    Ch. 2 = V$_{(OUT)}$    Ch. 3 = I$_{(P)}$    Ch. 4 = I$_{(LED)}$

**Figure 17. Constant Output Current With Heat Sharing Resistor**

# 9 Power Supply Recommendations

The TPS92612 is designed to operate from a power system within the range specified in the *Recommended Operating Conditions*. The SUPPLY input must be protected from reverse voltage and overvoltage over 40 V. The impedance of the input supply rail must be low enough that the input current transient does not cause drop below LED string required forward voltage. If the input supply is connected with long wires, additional bulk capacitance may be required in addition to normal input capacitor.

Product Folder Links: *TPS92612*
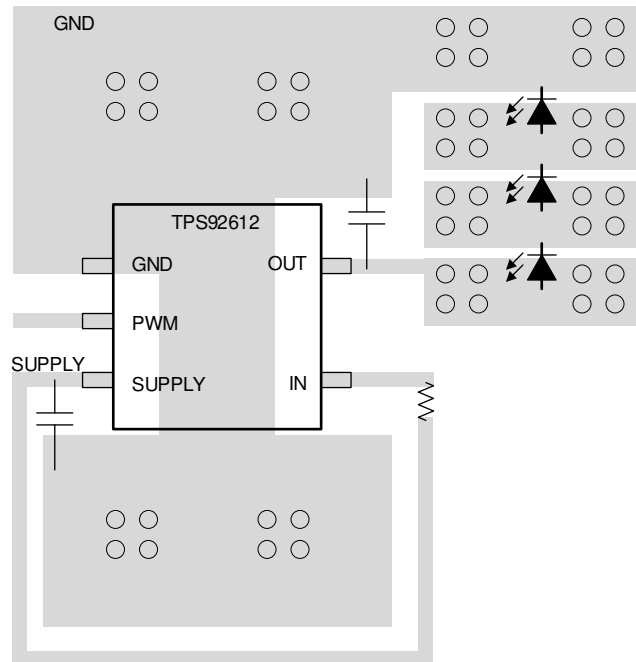
# 11 Device and Documentation Support

## 11.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 11.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

## 11.3 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

## 11.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 11.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

# 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS92612DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 22SF | Samples |

**(1)** The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

**(2) RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

**(3)** MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**(4)** There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

**(5)** Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

**(6)** Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TPS92612 :**

●Automotive: TPS92612-Q1

NOTE: Qualified Version Definitions:

●Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

![Texas Instruments logo] **PACKAGE MATERIALS INFORMATION**

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**



**TAPE DIMENSIONS**



| A0 | Dimension designed to accommodate the component width |
|----|-------------------------------------------------------|
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W  | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------|--------------|-----------------|------|-----|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS92612DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |

**TAPE AND REEL BOX  DIMENSIONS**



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TPS92612DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
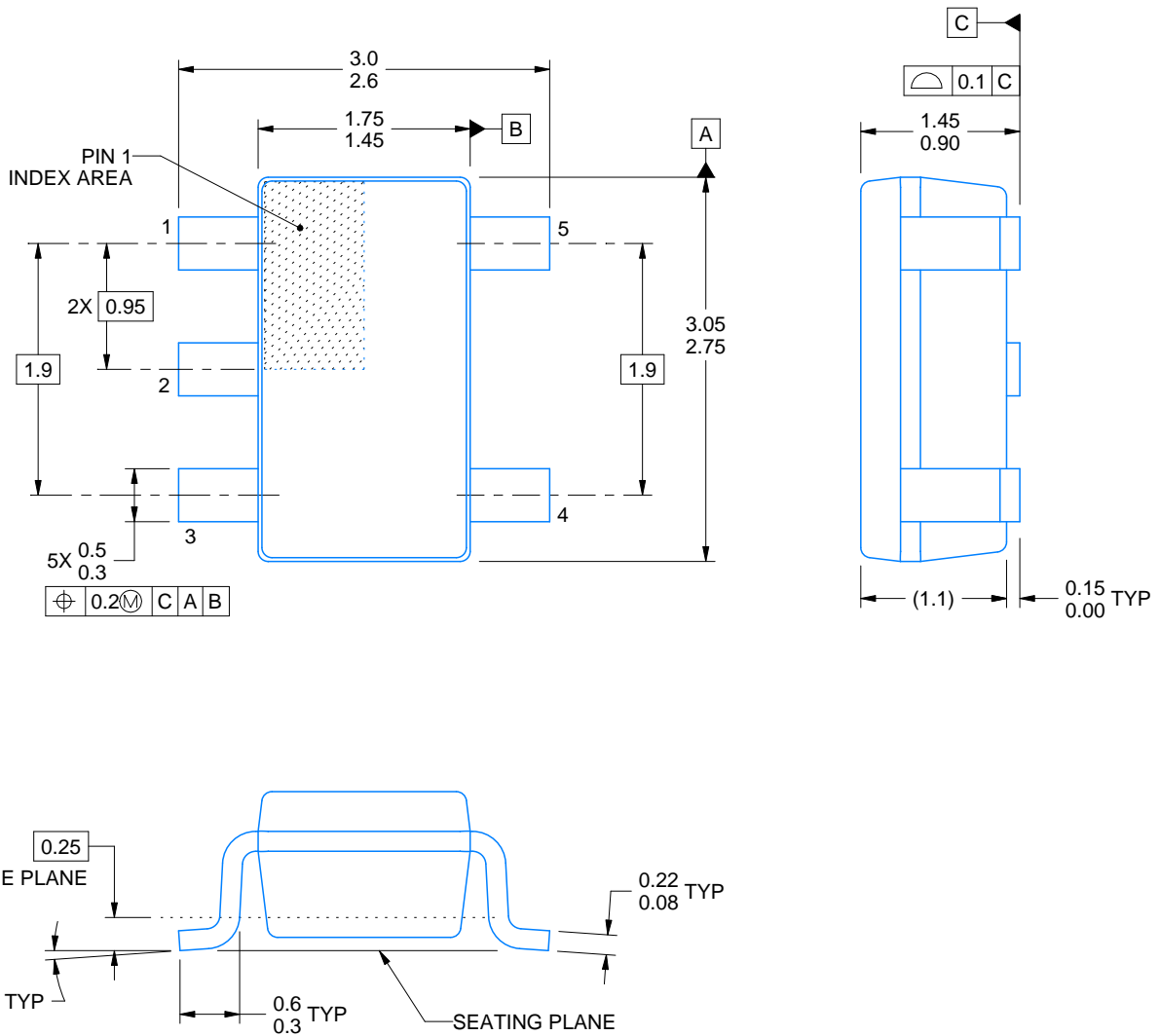
4214839/E   09/2019

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.

PKG ℄

5X (1.1)

1

5X (0.6)

5

2

SYMM ℄

(1.9)

2X (0.95)

3

4

(R0.05) TYP

(2.6)

LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

SOLDER MASK
OPENING

METAL

EXPOSED METAL

0.07 MAX
ARROUND

NON SOLDER MASK
DEFINED
(PREFERRED)

METAL UNDER
SOLDER MASK

SOLDER MASK
OPENING

EXPOSED METAL

0.07 MIN
ARROUND

SOLDER MASK
DEFINED

SOLDER MASK DETAILS

4214839/E   09/2019

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

PKG
℄

5X (1.1)

1

5X (0.6)

5

SYMM
℄

2

(1.9)

2X(0.95)

3

4

(R0.05) TYP

(2.6)

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214839/E   09/2019

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate
   design recommendations.
8. Board assembly site may have different recommendations for stencil design.